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ABSTRACT

This study was designed to determine the effects of variable and specific practice of typing individual letters on response time to typing those letters within specific letter combinations and on overall speed and accuracy of intermediate typists (46 high schools students who were taking Typewriting II). The letters selected for investigation were the "h" as it follows "t," the "e" as it follows "r," the "n" as it follows "i," and the "t" as it follows "i." Students were randomly assigned to three groups: variable practice, specific practice, or typing assignment (control). Pretests were given using three five-minute writings and individual tests of the specific two-letter combinations using the Apple microcomputer with the Mountain Computer Clock. Following 14 days of one-hour classes and a seven-day period of no treatment, the students were tested again using the same methods. Although previous research has suggested otherwise, this study found that neither the variable nor the specific practice drills proved to be more effective in improving response times to specific letters in two-letter combinations than using no drills at all. The study further found that drill work at the intermediate level of skill acquisition did not appear to be helpful to the typist in increasing speed or decreasing errors. Possible explanations suggested for these findings were that students learned letters in combinations (chain effect) and that once these chain reactions were established, drill on letters in isolations was not effective; also, findings showed that repetitive practice is less effective with older students or with students at intermediate levels than with younger or beginning students. Further research was recommended to determine if the use of drills is effective in typewriting instruction. (KC)

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THE EFFECTS OF VARIABLE AND SPECIFIC PRACTICE ON RESPONSE TIME TO INDIVIDUAL LETTERS AND ON OVERALL SPEED AND ACCURACY IN TYPEWRITING

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THE EFFECTS OF VARIABLE AND SPECIFIC PRACTICE ON RESPONSE TIME TO INDIVIDUAL LETTERS AND ON OVERALL SPEED AND ACCURACY IN TYPEWRITING

Schmidt (1975) proposed a theory of how skills are learned called a schema theory.

> The underlying principle is that with practice people develop certain rules, which Schmidt refers to as schemas about their individual motor behavior. The theory predicts that the rules people develop about their motor behavior will be more effective in action if the events that lead to the development of the rules are varied rather than constant. (Schmidt, 1982, p. 493)

To apply Schmidt's (1975) theory to typewriting, variable practice by the typist, whereby the same letter is practiced in a variety of combinations with other letters, would enhance the typist's discrete motor responses to those individual letters. For example, the more combinations of h to which the typist is exposed, the better the typist will handle responses to new combinations of h. Even if a particular combination has not been practiced, performance should be enhanced through variable practice. McCraken and Stelmach (1977) tested Schmidt's theory in a motor learning study and found variable practice more effective. Other motor learning studies by Kerr and Booth (1977, 1978), Allen (1978), and Wrisberg and Ragsdale (1979) have also supported Schmidt's theory on how skills are learned. While the schema theory associates practice with performance of a novel task, principles behind schema theory may be applied to the study of typewriting.

Farrell (1975) stated that skills can be classified as being open or closed. A closed skill is one where the environment is predictable because it is perfectly stable such as bowling, signing one's name to a check, or brushing one's teeth. An open skill is one where the environment is unpredictable because it is constantly changing such as returning a punt, wrestling, or typewriting. Even though the typist knows the location of the keys, the same copy is not typed every time. The copy is constantly changing. Of course, some skills would have environments that are semi-predictable and would fall somewhere between the open and closed continuum.

Based on their studies as well as others, Shapiro and Schmidt (1981) have generalized that if a skill is closed, then variability of practice is much more effective. There is evidence to suggest that variability of practice would be more effective for learning open skills as well, but it is an area that clearly needs more study.

Opinions vary as to the type of practice that is most beneficial to students in typewriting. Some writers support the idea of practice materials which are repeatedly typed by the students. Others support the idea of using more practice material which students type only one time each (Crawford & Robinson, 1976). Lauderdale (1972) studied the effects of intensive and extensive practice in typewriting on the development of speed and accuracy. She found no significant differences in either practice method for building speed. However, students who used the intensive, repetitive practice method showed significantly greater accuracy improvement. Mach (1972) found that beginning typists

who learned to type through nonrepetitive practice were able to type significantly faster and more accurately on straight-copy material than were students who learned to type through repetitive practice.

According to Schmidt (1975), when practicing a series of discrete motor responses, which is what is done in typewriting, it would be better to vary the practice because a person who has variable practice would be better equipped for a new situation. The more practice on a certain letter and varying combinations of that letter, the better equipped the typist would be to handle a new combination of that letter in context. West (1974) would agree with Schmidt to the point that practice should be extensive; however, he would place little value in drills designed to practice responses to individual keys or any practice drills beyond the initial keyboard learning stage. Robinson (1972, 1979), Russon (1973), Wanous (1973), and Wanous and Langford (1978) have all advocated drill work in typewriting. Robinson (1972) has stated that often the best method of improving stroking responses is through practice drills. He reported:

> The purpose of response pattern drills is to help the student: (1) recognize balanced-hand and one-hand words and word parts, (2) develop appropriate responses to these combinations of differing difficulties, and (3) weave his variable rhythm patterns into a continuous, fluent performance throughout the line and paragraph. (p. 19)

The textbooks used in many high school classrooms provide and recommend practice drills throughout the two-year typewriting course. Some typewriting books deal exclusively with basic typewriting drills (Wanous & Langford, 1978). Yet, there seems to be some question as to

the value of drillwork beyond the early stages of typewriting instruction.

In a study by Hayes (1978), responses of subjects to 29 characters (the 26 letters of the alphabet and 3 punctuation marks) were analyzed to obtain reaction times. The data in this study indicated that reaction time to individual characters on the keyboard may be directly correlated to typewriting rate. There is little generalization that can be made concerning reaction time among limbs of an individual because muscle type and quality and speed of nerve conduction differ among individuals (Henry & Rogers, 1960; Lotter, 1960). Also, the way individual fingers respond to a stimulus may vary (Clarke & Glines, 1962). However, there is research to support that response time can be improved through practice (Tripp, 1965).

Typewriting is classified as a psychomotor skill as well as an open skill which involves manipulative responses that require perceptual inputs, mental processes and finely coordinated muscular movements (Singer, 1972; Farrell, 1975). It is known that as skill increases, chaining of letters occurs, but it is also believed that single-letter responses are made by typists at all levels of typewriting. The study by Hayes (1978) suggested that there is a correlation between typewriting rate and individual responses to keys and characters on the typewriter keyboard. Schmidt's theory (1975) suggests that typewriting performance could be enhanced through variable practice. Also, according to Tripp (1965), there is research to support the conclusion that response time can be improved through practice.

Problem

This study was designed to determine the effects of variable and specific practice of individual letters on response time to those letters within specific letter combinations and on overall speed and accuracy of intermediate typists.

Subjects

The subjects for this study were 46 tenth-, eleventh-, and twelfth-grade high school students who were taking Typewriting II for the 1982-83 school year.

Procedures

The letters selected for investigation in this study were the h, e, n, and t. These letters are included in the top 10 most-used letters according to a computer analysis by Robinson (1972). Since the real task in learning to strike any letter is associating the responses to that letter with responses to other letters, this study further investigated responses to the selected letters within frequently appearing letter combinations: the h as it follows t (balanced-hand), the e as it follows r (left-hand), the n as it follows i (right-hand), and the t as it follows i (balanced-hand).

Students were randomly assigned to the following three treatment groups by means of a table of random numbers:

Group 1 - Variable Practice (Experimental)

Group 2 - Specific Practice (Experimental)

Group 3 - Typing Assignment (Control)

The three groups were then assigned to one of two classes so that part of each group was in each class. The classes met for one hour each day and were taught by the researcher.

Group 1 was treated with a variable practice approach. They were told they were practicing responses to four keys, the h, e, n, and t, in an effort to increase their overall speed and accuracy. They were given material which contained three- and four-letter words where the four letters appeared in a wide variety of combinations with other letters.

Group 2 was treated with a specific practice approach. They were told they were practicing exercises designed to increase overall speed and accuracy. They were given practice material which emphasized only the specific four keys being investigated in limited combinations with other letters, the h following t, the e following r, the n following i, and the t following i.

Group 3, the Control group, worked on a typical typing assignment consisting of number, capitalization, and punctuation rules in order to compile a reference booklet for use in class, and no practice exercises.

Three five-minute writings were given to access each student's base typewriting rate and accuracy score. The five-minute writings served as half of the the pretest. Students were individually tested as well on the Apple Microcomputer using the Mountain Computer Clock to time responses to each of the four characters within specific two-letter combinations. The individual testing served as the other half of the pretest.

Following the pretest, each group received their respective treatment for the next seven days. At that time, the students were given an

interim test. The interim test was exactly like the pretest which consisted of three five-minute writings and the individual testing. The groups again received their respective treatment for another seven days and were then given a posttest. Following these three days of testing, the students typed on their regular class assignments but were given no additional treatment. After another seven-day period, a follow-up test was given so that, in all, students were tested four times with treatment occurring between Trials 1 and 2, and between Trials 2 and 3. The treatment lasted for a period of seven days each time and was followed by three days of testing.

All five-minute writings were taken on the IBM Selectric typewriters using the same equivalent five-minute writings for all four tests. All practice material was typed on the IBM Selectric typewriters. All individual responses and letter combination responses were tested on the Apple Microcomputer using the same writing for all four tests, but scrambling the order of the four paragraphs each time. While the IBM keyboard and the Apple keyboard are different, all students in the study were subjected to the same differences and were given the same practice time.

Using the Mountain Computer Clock and the Apple Microcomputer, the mean response time was computed for each student for each letter in specific two-letter combinations.

The scoring procedures provided response time in seconds, typewriting rate in words per minute, and accuracy scores in total errors for the pretest (Trial 1), the interim test (Trial 2), the posttest (Trial 3), and the follow-up test (Trial 4).

Statistical Treatment

A multigroup pretest-posttest design was used for this study. Since there were three groups in this study, and individual responses to the four letters in specific combinations as well as speed and accuracy were being investigated, a multivariate analysis of variance was performed on the dependent measures for treatment effects at the .05 level of significance. The MANOVA was performed with the procedures available in MULTIVARIANCE IV (Finn, 1976).

Findings

Mean response times of the four letters in specific combinations were calculated by treatment group and appear in Table 1. The mean response times ranged from .238 seconds to .329 seconds. There was a difference of .098 seconds from the fastest mean time recorded to the slowest mean time recorded. The Variable Group had the fastest mean response times across the four trials on the h following t and the n following i. On the e following r, the Variable Group again had the fastest mean response times but only for the first and second trials. The Control Group was faster on the last two trials. The Control and Specific Groups had the fastest mean response times on the t following i; however, mean response times to the t following i were slower than the other three letters for all groups.

TABLE 1

MEANS OF RESPONSE TIMES TO SELECTED LETTERS IN SPECIFIC COMBINATIONS BY TREATMENT GROUPS

Groups	N	Trial 1 (Pretest)	Trial 2	Trial 3 (Post-test)	Trial 4
		H Following T			
Specific	15	.290	.305	.309	.261
Variable	16	.241	.238	.255	.241
Control	15	.274	.289	.300	.287
		T Following I			
Specific	15	.329	.320	.306	.279
Variable	16	.322	.329	.319	.313
Control	15	.282	.289	.296	.290
		N Following I			
Specific	15	.272	.293	.290	.258
Variable	16	.270	.265	.258	.241
Control	15	.323	.294	.292	.273
		E Following R			
Specific	15	.307	.307	.286	.302
Variable	16	.262	.258	.261	.251
Control	15	.270	.260	.239	.244

A multivariate analysis of variance was used to analyze responses to the four letters in specific combinations being investigated in this study. This analysis is analyzed in Table 2. There was a statistically significant multivariate difference for the main effects of trial and treatment. The treatment effect was the result of the statistically significant difference between the mean response time to the e following r for the Specific and Control Group, the Control Group being faster.

The trial effect was the result of the significant differences in the response times to the h following t and to the n following i between Trials 3 and 4; these were decreases in mean response time. There was no significant multivariate interaction effect.

TABLE 2

SUMMARY OF MULTIVARIATE AND UNIVARIATE ANALYSES OF VARIANCE FOR RESPONSE TIMES ON THE FOUR LETTERS IN SPECIFIC COMBINATIONS

Source	Variable	df	F^1	F^2	p
Treatment		8,80	2.380		.0236*
	Total H following T	2		2.0410	.1423
	Total T following I	2		.5720	.5688
	Total N following I	2		1.3955	.2588
	Total E following R	2		2.5295	.0915
	Error	43			
Trial		12,32	2.8187		.0096*
	T2-T1 H following T	1		1.3890	.2451
	T2-T1 T following I	1		.0102	.9202
	T2-T1 N following I	1		.1438	.7065
	T2-T1 E following R	1		.3177	.5760
	T3-T2 H following T	1		.8627	.3582
	T3-T2 T following I	1		.1342	.7160
	T3-T2 N following I	1		.3654	.5487
	T3-T2 E following R	1		2.5003	.1212
	T4-T3 H following T	1		5.8868	.0196*
	T4-T3 T following I	1		.6584	.4216
	T4-T3 N following I	1		17.8387	.0002*
	T4-T3 E following R	1		.2351	.6303
	Error	43			

Source	Variable	df	F^1	F^2	p
Treatment X Trial		24,64	1.3111		.1943
	T2-T1 H following T	2		.6904	.5069
	T2-T1 T following I	2		.0821	.9214
	T2-T1 N following I	2		1.9473	.1551
	T2-T1 E following R	2		.1116	.8947
	T3-T2 H following T	2		.0995	.9055
	T3-T2 T following I	2		.1474	.8634
	T3-T2 N following I	2		.0447	.9564
	T3-T2 E following R	2		1.0241	.3678
	T4-T3 H following T	2		1.3048	.2818
	T4-T3 T following I	2		.1985	.8207
	T4-T3 N following I	2		.7029	.5008
	T4-T3 E following R	2		1.1627	.3223
	Error	43			

NOTE: [1]Multivariate F
[2]Univariate F
*Significant difference ($p < .05$)

While the main purpose of the study was to investigate response times to selected letters within specific letter combinations using different practice approaches, overall speed and accuracy measures were also investigated in order to determine if either was affected by the treatment. Table 3 shows means and standard deviation of speed and accuracy scores on the IBM Selectric typewriters by treatment group.

TABLE 3

MEANS AND STANDARD DEVIATION OF SPEED AND ACCURACY SCORES ON THE IBM SELECTRIC BY TREATMENT GROUP

		Trial 1		Trial 2		Trial 3		Trial 4	
Group	N	WPM	ERR	WPM	ERR	WPM	ERR	WPM	ERR
Specific	15	37.07	11.71	39.65	13.33	40.29	10.78	42.49	10.96
Variable	16	38.21	11.83	40.44	14.40	40.31	12.48	42.50	12.23
Control	15	38.29	12.31	41.13	16.09	40.71	12.73	42.84	13.69
Overall		37.85	11.95	40.40	14.61	40.44	12.00	42.61	12.30
Standard Deviation		9.14	4.43	8.29	6.11	8.38	4.99	8.38	5.65

Multivariate analysis of variance was also used to analyze speed and accuracy scores obtained. Table 4 summarizes the multivariate and univariate analysis of variance on speed and accuracy scores obtained on the IBM Selectric. There was a statistically significant multivariate difference for the main effect of trial for both speed and accuracy scores. The univariate F-ratios showed differences in words per minute between Trials 1 and 2 and Trials 3 and 4; these were increases in words per minute. The univariate F-ratios showed differences in error scores between Trials 1 and 2 and Trials 2 and 3. Errors increased between Trials 1 and 2, but decreased between Trials 2 and 3.

TABLE 4

SUMMARY OF MULTIVARIATE AND UNIVARIATE ANALYSES OF VARIANCE FOR SPEED AND ACCURACY SCORES ON THE IBM SELECTRIC

Source	Variable	df	F^1	F^2	p
Treatment		4,84	.391		.8145
	Total WPM	2		.040	.9604
	Total Error	2		.754	.4766
	Error	43			
Trial		6,38	25.242		.0001*
	T2-T1 WPM	1		45.657	.0001*
	T2-T1 Error	1		16.322	.0003*
	T3-T2 WPM	1		.009	.9253
	T3-T2 Error	1		10.207	.0027*
	T4-T3 WPM	1		35.978	.0001*
	T4-T3 Error	1		.160	.6912
	Error	43			
Treatment X Trial		12,76	.651		.7916
	T2-T1 WPM	2		.226	.7903
	T2-T1 Error	2		.887	.4208
	T3-T2 WPM	2		1.019	.3696
	T3-T2 Error	2		.265	.7688
	T4-T3 WPM	2		.003	.9969
	T4-T3 Error	2		.249	.7808
	Error	43			

NOTE: [1]Multivariate F
[2]Univariate F
*Significant difference ($p < .05$)

Discussion

The reaction time studies that have been done in typewriting (Hayes et al., 1977; Hayes, 1978; Hayes & Halpin, 1978) measured reaction times to individual characters on the keyboard in isolation. The data from these studies indicated that reaction time to individual characters on the keyboard could be correlated directly to typewriting rate. This study measured response times in context rather than in isolation by observing four letters in specific combinations with four other letters; the h following t, the n following i, the t following i, and the e following r. Coover (1923) and Lahy (1924) have shown that intervals between strokes on the typewriter are not uniform, and responses vary according to what letter follows another letter. They concluded that balanced hand strokes are faster. In the present study, the fastest stroke was the e following r (same hand) and the slowest stroke was the t following i (balanced hand). Obviously, when analyzing rate of responses in context, distance traveled must be taken into consideration.

As skill increases, responses to various letter combinations increase. These responses are referred to as chaining. Little is known about how or when chaining occurs. It is believed to occur more frequently at high levels of typewriting (Fendrick, 1927; West, 1969), but chaining has been found to occur in groups typing between 16 to 23 GWPM (Langford, cited in Russon & Wanous, 1973). Once these chaining patterns have been developed, it is not known if practicing single letters in isolation would help or hinder a typist in attaining higher

speeds and greater accuracy. Once certain pattern responses have been developed, practicing isolated letters could interfere with the chained responses that the typist has already developed. The four letters in specific combinations used in this study were chosen because of their frequency of occurrence in typed copy. It is possible that no significant differences in response times between groups were found in this study because at the intermediate level, the chained responses for these particular letters in specific combinations had already been developed to the point that the practice procedures used were of little value in decreasing response times. It is also possible that by using a different practice approach or by practicing letters in specific combinations where chaining patterns would less likely have been developed, response times could be improved and thereby increase speed. This is an area in which more study is clearly indicated.

Robinson (1972, 1979), Wanous (1973), Russon (1973), and Wanous and Langford (1978) are all advocates of drill work in typewriting. Drill work is still an integral part of most current typewriting textbooks and is suggested as a daily activity in typewriting classes throughout the two-year course. However, the results of this study would suggest that even though the drills did not seem to hinder the typists, neither were there significant improvements as a result of the treatment. While drills may be effective at the skill acquisition stages of typewriting, they did not appear to be effective at the intermediate level. These findings have strong implications for instructional methodology in typewriting.

The significant trial effect that was found on the analyses of response times to the individual letters in specific combinations was for the h following t and the n following i between Trials 3 and 4. It is interesting to note that this was a time of no treatment, and that the significant trial effect was due to a decrease in mean response times for all groups. Statistically, there was no evidence to support that either of the practice methods, variable or specific, was better than no practice as evidenced by the performance of the Control Group. All groups appeared to progress equally throughout the study.

The largest increase in mean words per minute occurred between Trials 1 and 2 and Trials 3 and 4 for all groups. Errors increased between Trials 1 and 2 for all groups and decreased for all groups between Trials 2 and 3. This would support the generally accepted theory (West, 1969) that errors tend to increase as words per minute increase and then begin to level off.

Schmidt's (1975) theory suggested that variable practice is better when trying to improve responses; however, this study could not statistically support that theory. For the h following t and the n following i, the mean response times of the Variable Group were faster for every trial. On the e following r, the Variable Group had faster response times for the first two trials but the Control Group was slightly faster on the last two trials. Response times between the two groups were very close. On the t following i, the Variable Group was slower; however, the overall times for this letter combination were slower for all groups. In other studies testing Schmidt's theory, it was fou

that variable practice was more effective if used in the original practice phase (McCraken & Stelmach, 1977). It was also discovered that children responded better to variable practice than adults (Kerr & Booth, 1977, 1978). In this typewriting study at the intermediate level of typewriting, variable practice did not appear to be effective in reducing response time to the selected letters.

The data from previous reaction time studies (Hayes et al., 1977; Hayes, 1978; Hayes & Halpin, 1978) indicated that reaction time to individual characters could be correlated directly to typewriting rate. Also, according to Tripp (1965), there is research to support that response time can be improved through practice even though responses of individual fingers may vary (Clarke & Glines, 1962). However, neither practice method, variable nor specific, significantly decreased in-context response time to the four letters in specific combinations. Although research indicates that response time can be improved, neither experimental treatment accomplished that goal.

Conclusions

Based on the findings of this study, it has been concluded that:

1. Neither the variable nor the specific practice drills proved to be more effective in improving response times than using no drills at all.
2. Drill work at the intermediate level of skill acquisition did not appear to be helpful to the typist in increasing speed or decreasing errors.

3. The use of drill work as a part of daily warm-up in intermediate typewriting may not be the best way to utilize class time.

Recommendations

The following recommendations are made for further study:

1. A similar study should be conducted using letters in specific combinations where chaining patterns would less likely have been developed to see if overall response times could be improved.
2. A longitudinal study with beginning typists should be conducted to see how responses to individual characters within specified letter combinations develop over time.
3. A similar study should be conducted in beginning typewriting to determine if either variable or specific practice would improve responses to individual characters within specified letter combinations during the initial phases of typewriting skill acquisition.
4. A similar study should be conducted which includes younger students to determine if age and maturation as well as practice method have any effect on responses to individual characters in beginning typewriting.

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